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A proposal for a microcomputer-based physical qualifications monitoring system for the Branch Clinic, Bancroft Hall, Annapolis, Maryland.

Setzer, Richard C.

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NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

A PROPOSAL FOR A MICROCOMPUTER-BASED
PHYSICAL QUALIFICATIONS MONITORING SYSTEM
FOR THE BRANCH CLINIC, BANCROFT HALL,
ANNAPOLIS, MARYLAND

by

Richard C. Setzer

March 1986

Thesis Advisor: Taracad R. Sivasankaran

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The mission of the Branch Clinic, Bancroft Hall, is to meet the primary health care needs of the Brigade of Midshipmen, U. S. Naval Academy. Equally important, the Branch Clinic must monitor the physical qualifications of those midshipmen and make recommendations to Naval Academy authorities and higher echelon activities regarding their suitability to participate in ongoing professional development activities and for subsequent service as commissioned officers of the Navy and Marine Corps.

This thesis proposes a microcomputer-based Physical Qualifications Monitoring System for the Branch Clinic. Developed as a prototype, the system would provide the clinic staff with their first significant hands-on experience with current information systems technology and serve as a basis for a more fully developed microcomputer-based system or as a preliminary requirements

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specification for a mainframe-based system.

A Proposal for a Microcomputer-Based Physical Qualifications
Monitoring System for the Branch Clinic, Bancroft Hall,
Annapolis, Maryland

by

Richard C. Setzer
Lieutenant, Medical Service Corps, United States Navy
B.S., The George Washington University, 1980

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I. INTRODUCTION

The mission of the Branch Clinic, Bancroft Hall, is to meet the primary health care needs of the Brigade of Midshipmen, U. S. Naval Academy. Equally important, the Branch Clinic must monitor the physical qualifications of those midshipmen and make recommendations regarding their suitability to participate in professional development activities and for subsequent service as commissioned officers of the Navy and Marine Corps. These recommendations are provided to both Naval Academy authorities and higher echelon acitivies (e.g., Naval Aerospace Medical Institute, Naval Medical Command, Naval Military Personnel Command, Commandant of the Marine Corps).

To date, the Branch Clinic has monitored physical qualifications without data processing support. This thesis proposes a microcomputer-based Physical Qualification Monitoring System (PQMS) to augment existing manual procedures. The system is designed to help the Branch Clinic answer inquiries on the physical status of midshipmen and in preparing precommissioning physical examinations. Developed as a prototype, this system would provide the clinic staff with their first significant experience with current information systems technology. The proposed PQMS could, in turn, serve as the basis for a more fully

developed microcomputer-based system or as a preliminary
requirements specification for a mainframe-based system.

The thesis first describes the organizational context
and overviews the problem. These sections are based
primarily on personal experience as Administrative Officer,
Branch Clinic, Bancroft Hall, during the period January 1982
through July 1984, supplemented by telephone conversations
with the current staff and a site visit during December
1985. Next, general characteristics of the PQMS proposal
are examined, including design objectives methodology. The
system outputs are then discussed, followed by the data
structures and processing modules. The summary presents the
proposed hardware/software configuration of the system,
highlights what PQMS is and is not, and offers some possible
extensions to underlying concepts.

The reader will find that this thesis is more pragmatic
than theoretic. The information systems concepts are well-
established in the literature; no new theory or technology
is required or advocated. Rather these concepts are simply
brought to bear on a real-life problem which has thus far
gone unaddressed. Where appropriate, theory is discussed,
but only to a level consistent with the needs of the reader.
Every effort is made to focus on the problem, without
obscuring key issues with unwarranted detail.

II. ORGANIZATIONAL CONTEXT

A. MISSION AND ORGANIZATION OF THE U. S. NAVAL ACADEMY

The mission of the U. S. Naval Academy (USNA) is to prepare midshipmen for service as commissioned officers of the Navy and Marine Corps. To accomplish this, particular emphasis is placed on the development of a midshipman as a whole--academically, professionally, morally, and physically [Ref. 1:p. 22]. The organization of the Naval Academy reflects this proven approach.

The Superintendent has overall responsibility for the Naval Academy and its large support complex. His principle assistants for the general administration of the Annapolis Area complex are his immediate personal staff, the Deputy for Operations, and the Deputy for Management. Regarding matters specific to the Brigade, the Dean of Admissions, Academic Dean, and Commandant of Midshipmen assist the Superintendent in the recruitment and subsequent academic and professional development of midshipmen.

Of these, the Commandant of Midshipmen is most directly involved with the day-to-day functioning of the Brigade and responsible for the uniquely military aspects of midshipmen development--professional, moral, and physical [Ref. 1:p. 24]. Several departments under the Commandant assist him with this task. The Division of Professional Development

(PRODEV) conducts ongoing training in professional areas,
such as leadership, military law, seamanship, and
navigation. This division also coordinates the summer
cruise program, providing midshipmen with operational
experience with fleet and shore-based units of the Navy and
Marine Corps, and the service selection process by which
individuals choose the warfare specialty in which they will
serve subsequent to graduation. The Brigade Officers and
Brigade Chaplains share responsibility for the moral
development of midshipmen through a blend of religious
activities, leadership, guidance, and personal example. The
physical development of the Brigade is primarily handled by
the Physical Education Department, which provides formal
physical education courses and coordinates an extensive
intercollegiate and intramural sports program.

The organization of the Brigade of Midshipmen itself
also contributes to accomplishment of the Naval Academy
mission. The Brigade is divided into six battalions, each
headed by a senior officer (rank of O-5 or O-6) of the Navy
or Marine Corps. A battalion, in turn, consists of six
companies, each under command of a Company Officer from the
Navy or Marine Corps (rank of O-3 or O-4). The company is
the basic organizational unit of the Brigade and consists of
approximately 125 midshipmen. Midshipmen from all four
classes (or year group levels) are assigned to each company.
[Ref. 1: p.24]

B. MISSION AND ORGANIZATION OF THE NAVAL MEDICAL CLINIC AND
    BRANCH CLINIC, BANCROFT HALL

The Naval Medical Clinic (NMCL), Annapolis, is a tenant
command of the U. S. Naval Academy, responsible for
providing general/specialized outpatient clinic services
primarily for active duty Navy and Marine Corps personnel,
midshipmen, and active duty members of other Federal
Uniformed Services. NMCL Annapolis also provides outpatient
care to other eligible beneficiaries of the Annapolis Area
complex (e.g., dependents of active duty personnel, retirees
and their dependents, etc.) on a space-available basis.
This activity is organized under a Commanding Officer who
reports directly to the Commander, Naval Medical Command,
National Capital Region, Bethesda, Maryland, and to the
Superintendent, USNA, for additional duty and area
coordination. [Ref. 2]

NMCL Annapolis is physically and functionally divided
into two distinct units, the Main Clinic and Branch Clinic,
Bancroft Hall. The Main Clinic is off the main USNA campus
in the buildings which formerly comprised the Naval Hospital,
Annapolis. In general, this unit consists of the Office of
the Commanding Officer, all administrative support elements
of the command, ancillary support services (i.e., Laboratory
Pharmacy, and Radiology), and those clinical services
provided primarily for non-active duty beneficiaries, such
as Primary Care, Pediatrics, and Occupational Health.

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The Branch Clinic is on the main campus of the Naval Academy in the basement of Bancroft Hall, the dormitory facility for the Brigade of Midshipmen. This clinic is organized under the Senior Medical Officer and consists of several small, but distinct work centers, including Military Sick Call, Physical Examinations, Treatment Room, Observation Ward, Orthopedics/Sports Medicine, Physical Therapy, Optometry, and satellites of the ancillary support services at the Main Clinic. The primary beneficiaries of the Branch Clinic are the Brigade and the active duty staff of the Naval Academy.

C. NAVAL ACADEMY/BRANCH CLINIC RELATIONSHIP

The Senior Medical Officer reports directly to the Commanding Officer, NMCL Annapolis. Due to the close relationship between the Naval Academy and Branch Clinic, however, the Senior Medical Officer also has additional duty orders to the Superintendent. This relationship has three dimensions which parallel the "life cycle" of a midshipman.

First, the Senior Medical Officer is a member of the USNA Admissions Board. Each year this board, chaired by the Superintendent, reviews the qualifications of the 14,000+ applicants for admission to the Naval Academy to arrive at a plebe (freshman) class of approximately 1300. The Senior Medical Officer's role on this board is to establish the medical qualifications of the applicants. The principle

vehicle for that determination is the candidate medical examination, conducted under the auspices of the Department of Defense Medical Examination Review Board (DODMERB). An interservice agency, DODMERB is responsible for scheduling the medical examinations for candidates to all service academies and ROTC programs and for making preliminary determinations on the medical status of the candidates. DODMERB forwards their findings for use by the USNA Admissions Board. The Senior Medical Officer advises the Board regarding medical standards and the implications of waivering those standards on an individual's tenure as a midshipman and on possible limitations to career prospects and duty assignments.

Second, the Branch Clinic is responsible for maintaining the good health of the Brigade of Midshipmen. This is done through routine sick call, specialty clinics, immunizations, screening tests and examinations, and health education programs. When the level of care needed by a midshipman is beyond their capabilities, the clinic staff coordinates that care with nearby military treatment facilities and, if warranted, with civilian facilities.

Finally, the Branch Clinic monitors the physical qualifications of the 4500+ members of the Brigade. This task has both short and long term considerations. On the short term, the Senior Medical Officer must ensure that individuals are medically qualified to perform their duties

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on a day-to-day basis and to participate in their physically demanding professional development activities. From a long-term perspective, he must also make recommendations to higher authority regarding their suitability to serve as commissioned officers of the Navy and Marine Corps following graduation.

It is important to note that although the Senior Medical Officer reports to the Superintendent for additional duty, he is more directly influenced by and responsible to the Commandant of Midshipmen for several reasons. Not only is the Commandant invariably a flag officer or flag-selectee, but he is also a line officer, whereas the Senior Medical Officer is junior (specifically, a Captain) and from a staff corps. Both the primary beneficiaries and the building containing the Branch Clinic are under control of the Commandant. Furthermore, those Naval Academy authorities most involved with the daily activities and future careers of the Brigade, the Brigade Officers and Division of Professional Development, also work for the Commandant.

III.   PROBLEM STATEMENT/PROPOSED SOLUTION APPROACH

A.   PROBLEM OVERVIEW

Throughout an individual's four years as a midshipman, much pertinent information is documented in the Health Record regarding physical qualifications.   Sources include the candidate physical examination for admission into the Naval Academy; documentation of routine health care; hospitalization and surgery reports; Medical Boards; and special purpose screenings, tests, and examinations. However, this information has never been fully integrated to provide readily accessible physical qualification profiles on the Brigade.   The only means of obtaining even a preliminary indication of a midshipman's physical qualification status is to review that individual's Health Record vis-a-vis the physical standards established by higher authority.   This is a time-consuming process which currently must be repeated for each separate inquiry and requires detailed knowledge of physical standards by the reviewer.   When requests are received for information involving large segments of the Brigade (e.g., Which midshipmen in a given year group are physically qualified for duty as Naval Aviators or Naval Flight Officers?), the Branch Clinic must manually review all pertinent Health Records to respond, often to the exclusion of other work.

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Due to the Health Record layout, this review process can lead to important data being overlooked, especially when the reviewers are inexperienced. This is of particular concern since the Branch Clinic must augment its staff with health care providers from other naval medical facilities and Naval Reserve units to complete the annual precommissioning physical examination evolution. Although these providers are competent in their own right, they are often unfamiliar with current standards and the exacting requirements of these physical examinations and are apt to overlook critical data in the Health Record.

B. PROPOSAL

Given the volume of queries and physical examinations handled by the Branch Clinic each year, the need exists for current, easily retrievable physical qualification profiles on all midshipmen. This thesis proposes a microcomputer-based Physical Qualification Monitoring System (PQMS) to meet that need. With such a capability, the Branch Clinic would be more responsive to inquiries from Naval Academy authorities regarding the physical qualifications of midshipmen. Additionally, the accuracy of precommissioning physical examinations generated by the Branch Clinic would be enhanced, so that midshipmen are recommended for only those warfare specialties they are physically qualified for.

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C. SECONDARY DESIGN OBJECTIVES

Several secondary objectives motivated the design of the prototype Physical Qualifications Monitoring System. The most important of these are presented below in their approximate order of importance:

1. Minimize the risk exposure of the Branch Clinic.

At least three factors affect the degree of risk in any information systems project [Ref. 3:pp. 313-314]:

- Project size (the larger the project, the greater the risk),

- Experience with the technology to be employed (the greater the prior experience, the lesser the risk--and vice versa), and

- Project structure (the more well-defined and fixed the system outputs, the lesser the risk).

Clearly, all risk cannot be avoided. This is especially true in this instance with regard to experience with the technology.

Nolan has identified four phases of organizational learning relevant to information systems technology. These range from identifying a technology of potential value to an organization and undertaking a pilot project (Phase 1) to widespread technology diffusion where experience in one branch of an organization is easily transferred to other branches (Phase IV). [Ref. 3:p. 30] The only known automated data processing experience of the Branch Clinic is the use of punched cards for immunization evolutions and the casual use by a limited number of staff of the Brigade

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Roster System on the Naval Academy Time-Sharing System to generate rosters of midshipmen.

According to Nolan's scheme, then, the clinic is clearly at the beginning of Phase I, where the risks to an organization are inherently higher. To counteract this, emphasis focused on the other two risk factors. The outputs of the system were identified early and fixed in both form and content. By keeping these outputs to the minimum needed to evaluate the PQMS prototype and meet the reporting needs of the Branch Clinic, the project was also kept to a manageable size.

2. Minimize the time investment to learn and to use the prototype.

Key to the acceptance of any system is that the users be able to learn and use the system quickly. To achieve this, the PQMS Users' Manual is less than 40 pages long and provides step-by-step instructions for all processing modules, including very detailed explanation of those off-line procedures involving the Naval Academy Time-Sharing System. The system is itself menu-driven so that the user need not understand the underlying programs and programming language. Personal data (e.g., name, Social Security number, date of birth, etc.) is downloaded from existing Naval Academy files so that this data does not have to be rekeyed or maintained by the Branch Clinic staff.

3. Provide mechanisms for data security.

Although PQMS is a prototype, the system stores
personal data covered by the Privacy Act of 1974 and
sensitive medical information. Security against
unauthorized access, therefore, is a prime concern, so
appropriate safeguards are part of the design. Users must
enter a password to log onto the system, and the password
can be easily changed once successfully logged on. Privacy
Act Warning statements are displayed on entering and exiting
the program. Two types of reports are provided, detailed
reports for use within the Branch Clinic and summary reports
for distribution outside the clinic.

4. Provide a repository for current physical standards
    information.

Continuity is a problem at any military activity due
to the frequent rotation of personnel. The Branch Clinic is
no exception, with a new Senior Medical Officer and Head,
Physical Examinations Department, reporting aboard every few
years. Therefore, the PQMS was designed to store detailed
physical standards information which would be preserved
despite staff changes.

D. DESIGN METHODOLOGY

To facilitate development of the PQMS, considerable
thought was devoted to which of two common design
methodologies to use: i) data flow-oriented, ii) data
structure-oriented. The former, data flow-oriented design,

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considers information as a continuous "flow" from input
through a series of transforms (processes) to output. This
data flow is mapped to provide a representation of software
structure. [Ref. 4:pp. 178-179]

Although data flow-oriented design can be used for a
broad range of applications and is probably more widely
documented in the literature, a data structure-oriented
design approach was chosen for FQMS. This was primarily due
to the well-defined structure of the inputs, data base
files, and outputs of the system. Data structure-oriented
design proposes that where such well-defined structures
exist, they can be used as the basis for software
development. Rather than considering data flows and data
flow diagrams, this approach transforms representations of
data structure into representations of software structure.
The procedural aspects of processing modules are essentially
a by-product of data structure. [Ref. 4:pp. 205-207]

IV.   PQMS OUTPUTS

The intent of the Physical Qualifications Monitoring System is to provide current, easily retrievable physical qualification profiles on all Naval Academy midshipmen. The form and content of these profiles, in turn, are based on the information needs of both the direct users (the Branch Clinic staff) and indirect users (all others to whom information from the system is provided).

PQMS provides information at two levels of detail. To answer inquiries on specific midshipmen and to facilitate the annual precommissioning physical examination evolution, detailed reports are needed. These show not only an individual's physical qualification status by warfare specialty, but also the disqualifying conditions, standards, and waivers which underlie those determinations. To answer inquiries from outside the clinic on organizational segments of the Brigade, such as a company or year group, summary reports which show physical qualification status by warfare specialty are adequate. The next two sections discuss the specific format and content of these detailed and summary reports.

A.   DETAILED REPORTS

Figure 1 shows the general format of the detailed reports produced by PQMS.

```
+------------------------------------------------------------------------+
|                                                                        |
|                                                                        |
|      Name:  MCGIFFIN        PHILO              Alpha:  891234   Co#:  09 |
|      SSN:   123456789    Sex:  M    DOB:  620727                        |
|                                                                        |
|      Code         Disqualifier        Date   AIR NFO OPS WAR SUB NUC URL MC RL |
|                                                                        |
|      XXXXX XXXXXXXXXXXXXXXXXXXXXXXXXX XX/XX/XX XX  XX  XX  XX  XX  XX  XX  XX  XX |
|             .            .               .     .   .   .   .   .   .   .   .   . |
|             .            .               .     .   .   .   .   .   .   .   .   . |
|             .            .               .     .   .   .   .   .   .   .   .   . |
|                                                                        |
|                                   Summary:  XX  XX  XX  XX  XX  XX  XX  XX  XX |
|                                                                        |
|      Comments:                                                         |
|                                                                        |
|      XX/XX/XX    XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX |
|             .                          .                               |
|             .                          .                               |
|             .                          .                               |
|                                                                        |
|                                                                        |
+------------------------------------------------------------------------+
```

Figure 1.   Detailed Physical Qualification Status Report

The heading data on this report is self-explanatory, except

for "Alpha:."   The alpha number is a numeric identifier

assigned to each midshipman on entry into the Naval Academy

and is the key for most records maintained by the Naval

Academy.   It is formed by concatenating the last two digits

of midshipman's year group with a four-digit number

representing the alphabetized position of that person's name

within the Brigade.

The next section of the report is a detailed and

summarized listing of physical qualification status

information.   For each disqualifying condition recorded for

a midshipman, a text description and date stamp (reflecting

how current that entry is) is shown. In addition, a set of
"flags" reflects the impact of that disqualifier on the
midshipman's eligibility for the various warfare
specialties. The column headers for these flags represent
the following specialty groups:

AIR — Naval Aviator   NUC — Surface Nuclear

NFO — Naval Flight Officer   URL — Unrestricted Line

OPS — Special Operations   MC — Marine Corps

WAR — Special Warfare   RL — Restricted Line/
                                         Staff Corps
SUB — Submarine Duty

The flags themselves can assume one of the following values:

PQ — physically qualified

WG — not physically qualified/waiver granted by higher
     authority

LW — not physically qualified/limited waiver granted by
     higher authority

WR — not physically qualified/waiver requested from higher
     authority

UE — undergoing evaluation/status indeterminate at this
     time

NQ — not qualified

The summary flags show the overall impact of the individual
flags on a midshipman's physical qualification status for
each warfare specialty.

The final section of the detailed report displays
free-text comments. These are limited to 60 characters
each, date stamped, and provide information specific to a
midshipman which the PQMS cannot otherwise store.

The detailed report format is generic and can be generated three different ways. First, a single report can be displayed on the CRT screen of the microcomputer. Because of the 80 x 25 character size limitation of a CRT, the report is split into two screens, one containing the header and disqualifier information and the other containing any comments. Second, the user can direct the output to an attached printer, producing a single-sheet report. Finally, a series of detailed reports on all midshipmen in a given company and year group can be directed to the printer. This option is primarily intended to facilitate the annual precommissioning physical examination process by providing reports in the same logical unit that the examinations are processed.

B. SUMMARY REPORTS

Figure 2 shows the general format of the summary reports produced by PQMS.

Given the discussion of the prior section, the contents of this report need no additional explanation. The report simply shows physical qualification summaries for whichever of two categories of midshipmen is chosen, either a year group sorted by company or a company sorted by year group. In both cases, each distinct subgroup (company or year group, respectively) is listed on a separate sheet of paper.

```
+-------------------------------------------------------------------------+
:                                                                         :
:                                                                         :
:                      BRANCH CLINIC, BANCROFT HALL                       :
:                        ANNAPOLIS, MD  21402                             :
:                                                                         :
:                  PHYSICAL QUALIFICATIONS STATUS REPORT                  :
:                                                                         :
:       ALPHA           NAME           DATE    AIR NFO OPS WAR SUB NUC URL MC  RL  :
:                                                                         :
:    ** COMPANY ## (or YEAR GROUP ##)                                     :
:    XXXXXX  XXXXXXXXXXXXXXXXXXXXXXXX  XX/XX/XX  XX  XX  XX  XX  XX  XX  XX  XX  XX  :
:       .              .               .      .   .   .   .   .   .   .   .   .  :
:       .              .               .      .   .   .   .   .   .   .   .   .  :
:       .              .               .      .   .   .   .   .   .   .   .   .  :
:       .              .               .      .   .   .   .   .   .   .   .   .  :
:                                                                         :
+-------------------------------------------------------------------------+
```

Figure 2.   Summary Physical Qualification Status Report

C.   DISQUALIFICATION CODES REPORT

The PQMS can also produce printouts of its data base of
physical standards in the format shown in Figure 3.   The
code listed in this report is a five-character, alphanumeric
identifier which uniquely identifies each standard in the
data base.   The text description, date stamp, and flag
fields are analogous to those of the detailed physical
qualification status report with one exception.   The flags
can only assume values of PQ or NQ.   The standards data
file is discussed in greater detail in the next chapter.

PQMS can sort and print these listings either by code or
alphabetically.   The report is designed for use as a
reference guide when recording disqualifiers for midshipmen,
eliminating the need to commit the codes and text

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```
+-------------------------------------------------------------------------------+
|                                                                               |
|                                                                               |
|                        BRANCH CLINIC, BANCROFT HALL                           |
|                          ANNAPOLIS, MD  21402                                 |
|                                                                               |
|                        DISQUALIFICATION CODES                                 |
|                                                                               |
|       CODE        DISQUALIFIER         DATE    AIR NFO OPS WAR SUB NUC URL MC RL |
|                                                                               |
|       XXXXX   XXXXXXXXXXXXXXXXXXXXXXXXX XX/XX/XX  XX  XX  XX  XX  XX  XX  XX  XX  XX |
|          .             .                  .     .   .   .   .   .   .   .   .   . |
|          .             .                  .     .   .   .   .   .   .   .   .   . |
|          .             .                  .     .   .   .   .   .   .   .   .   . |
|          .             .                  .     .   .   .   .   .   .   .   .   . |
|                                                                               |
|                                                                               |
+-------------------------------------------------------------------------------+
```

Figure 3.   Disqualification Codes Report

descriptions to memory.   In addition, the listings can be

distributed outside the Branch Clinic, either as a reference

guide for the indirect PQMS users or for validation of the

standards data by higher authority (e.g., Naval Aerospace

Medical Institute or Naval Medical Command).

V.   DATA STRUCTURES

The data structures of the Physical Qualifications Monitoring System provide the basis for the outputs and processing modules of the system.   These structures are based on the relational data base model and implemented using the popular microcomputer product, dBASE III. This chapter provides a brief overview of this model and then a detailed discussion of the five PQMS data base files: BRIGADE, STANDARDS, DISQUALIFIERS, COMMENTS, and SUMMARY.

A.   OVERVIEW OF RELATIONAL DATA BASE MODEL

The relational model uses two-dimensional tables to represent data.   These tables (or relations) have several important properties.   Each entry in the table can contain only a single-value; repeating groups or arrays cannot be used as entries.   Each column has a unique name and is called an attribute or field.   All entries within a column are of the same type and come from the same domain of permissible values.   The rows of the relation are the individual records of the data base file.   No two rows in the table may be identical, and each row is identified by a unique key formed by some attribute or combination of attributes from the relation.   The relational model not only requires each record to have a primary key, but also permits alternate keys if they too are unique.   [Ref. 5:pp. 243-245]

As is the case with the PQMS, a data base usually consists of several different relations or tables. Key questions are then: What kinds of relationships can exist among the tables and how are they represented? There are three basic types of relationships. A tree, also known as a hierarchy, consists of a collection of records and one-to-many relationships among records. Each record can have one and only one parent. A simple network relaxes this definition slightly, so that a record can have more than one parent so long as they are of different types. Lastly, a complex network consists of a collection of records and many-to-many relationships (i.e., records may have multiple parents including some which are of the same type). [Ref. 5:p. 117-122] As illustrated later in this chapter, PQMS uses both the tree (between the BRIGADE and COMMENTS data base files) and complex network (between the BRIGADE and STANDARDS data base files).

Just as different types of relationships may exist among relations, so too can the relationships be represented in various ways. The relational model is noteworthy in that the table entries themselves identify any relationships, rather than requiring them to be explicitly defined when the logical format of the data base is first specified. The table entries typically used for this purpose are the record keys (or portions of them), although this is not always

true.   Relationships among the PQMS data base files are
defined exclusively by record keys.

B.   BRIGADE DATA BASE FILE

The BRIGADE data base file contains personal,
non-medical data on each midshipman.   Figure 4 describes
this file.   The data elements are a subset of those
contained in the Brigade Roster File (BROSTER), a well-
established data base maintained by the Midshipman Personnel
Office.   The procedural aspects of downloading this data to
the PQMS microcomputer are given in the next chapter.

Two keys are used for BRIGADE, Alpha and SSN.   Both are
unique and allow the user more flexibility in querying PQMS.
In addition, the file is indexed (i.e., sorted) on three
different fields, Alpha, SSN, and the concatenation of
Company+Alpha, to accelerate search routines and overall
program execution, as well as to properly sequence printed
outputs.

C.   STANDARDS DATA BASE FILE

Figure 5 describes the STANDARDS data base file.   In
essence, this file is the Branch Clinic's corporate memory
of the physical standards contained in the Manual of the
Medical Department and other pertinent directives.   Each
record in STANDARDS includes a unique code established by
the Branch Clinic, a text description of the disqualifying
condition, and a series of nine flags which reflect the

30

```
+-----------------------------------------------------------------------+
|                                                                       |
|     Data Base File:  BRIGADE                                          |
|                                                                       |
|     Description:    Personal, non-medical data on each midshipman     |
|                                                                       |
|     Data Elements:                                                   |
|                                                                       |
|           Field Name   Type    Length    Remarks:                    |
|                                                                       |
|           Alpha        Char      6       The first two digits of the alpha number |
|                                          are the last two digits of the year      |
|                                          in which the midshipman will graduate.   |
|                                          The remaining four digits are reflect     |
|                                          the alphabetized position of the          |
|                                          midshipman's name within the Brigade,     |
|                                          without regard to year of graduation.     |
|                                          EXAMPLE:  891234                          |
|                                                                       |
|           SSN          Char      9       Social Security Number of midshipman,     |
|                                          non-hyphenated.                           |
|                                          EXAMPLE:  123456789                       |
|                                                                       |
|           Last         Char     20       Last name of midshipman, in all capital   |
|                                          letters and padded with blanks to the     |
|                                          right as necessary.                       |
|                                          EXAMPLE: MCGIFFIN                         |
|                                                                       |
|           First        Char     15       First name of midshipman, in all capital  |
|                                          letters and padded with blanks to the     |
|                                          right as necessary.                       |
|                                          EXAMPLE:  PHILO                           |
|                                                                       |
|           Sex          Char      1       Sex of midshipman, M (male) or F (female).|
|                                          EXAMPLE:  M                               |
|                                                                       |
|           DOB          Char      6       Midshipman's date of birth, YYMMDD format.|
|                                          EXAMPLE:  620727                          |
|                                                                       |
|           Company      Char      2       Company to which midshipman is assigned,  |
|                                          expressed as two digits (01,...,36).      |
|                                          EXAMPLE:  09                              |
|                                                                       |
|     Primary Key:  Alpha                                               |
|     Alternate Key:  SSN                                               |
|                                                                       |
|     Indexes:  Alpha, SSN, Company+Alpha                               |
|                                                                       |
+-----------------------------------------------------------------------+
```

Figure 4.   Description of BRIGADE Data Base File

```
+---------------------------------------------------------------+
|                                                               |
|     Data Base File:   STANDARDS                               |
|                                                               |
|     Description:      Physical standards from the Manual of the Medical Department and |
|                       other pertinent directives              |
|                                                               |
|     Data Elements:                                            |
|                                                               |
|          Field Name    Type    Length    Remarks:            |
|                                                               |
|          Code          Char      5       Alphanumeric code based on International |
|                                          Classification of Diseases, 9th Edition, |
|                                          Clinical Modification, which uniquely |
|                                          identifies the disqualifying condition. |
|                                          EXAMPLE:  36850      |
|                                                               |
|          Text          Char     25       Text description of the disqualifying |
|                                          condition, using generally accepted |
|                                          medical terminology and abbreviations |
|                                          as needed to restrict the description |
|                                          to 25 characters or less. |
|                                          EXAMPLE:  COLOR VISION DEFICIENCY |
|                                                               |
|          AIR_std       Char      2       Flag which indicates whether the disqual- |
|                                          ifying condition would render a |
|                                          midshipman physically qualified (PQ) |
|                                          or not physically qualified (NQ) for |
|                                          duty as a student naval aviator. |
|                                          EXAMPLE:  NQ         |
|                                                               |
|          NFO_std       Char      2     * SAA, except student naval flight officer. |
|          OPS_std       Char      2       SAA, except special operations duty. |
|          WAR_std       Char      2       SAA, except special warfare duty. |
|          SUB_std       Char      2       SAA, except submarine duty. |
|          NUC_std       Char      2       SAA, except surface nuclear duty. |
|          URL_std       Char      2       SAA, except unrestricted line. |
|          MC_std        Char      2       SAA, except U. S. Marine Corps. |
|          RL_std        Char      2       SAA, except restricted line/staff corps. |
|                                                               |
|          Date          Date      8       Date of most recent update to standard, |
|                                          MM/DD/YY format.     |
|                                          EXAMPLE:  03/27/86   |
|                                                               |
|     Primary Key:  Code                   * SAA - Same as above |
|                                                               |
|     Indexes:  Code, Text                                      |
|                                                               |
+---------------------------------------------------------------+
```

Figure 5.   Description of STANDARDS Data Base File

impact of that condition on a midshipman's physical

qualification for the various warfare specialties. The

record also carries a date stamp showing when the entry was

most recently updated. The key for STANDARDS is the Code

field, and the file is indexed on both the Code and Text

fields.

Some attributes of the STANDARD data base file warrant

further elaboration. The Code field has been designed to

accommodate the coding scheme of the International

Classification of Diseases, 9th Revision, Clinical

Modification (ICD-9-CM). Basically, ICD-9-CM categorizes

diseases and injuries and assigns a five-digit code to each.

The first three digits identify the system of the body

affected; the last two digits add the necessary detail to

identify the specific disease or injury. Figure 6 shows the

major classifications of ICD-9-CM and their three-digit

rubrics. [Ref. 6]

The ICD-9-CM coding scheme was chosen for two reasons.

First, ICD-9-CM is used throughout the Navy to classify

morbidity and mortality information for statistical reports

and to index medical treatment records by disease or injury.

Therefore, the coding scheme is a familiar one and

eliminates the need to develop a scheme unique to PQMS.

Second, DODMERB is currently developing a new dictionary of

disqualification codes based on ICD-9-CM, which the Branch

Clinic could adapt to meet their own needs. This would both

```
+----------------------------------------------------------------------+
|                                                                      |
|                                                                      |
|        Code Series                        Classification             |
|                                                                      |
|       00100 - 13999          Infectious and Parasitic Diseases       |
|       14000 - 23999          Neoplasms                               |
|       24000 - 27999          Endocrine, Nutritional, and Metabolic Diseases |
|                                  and Immunity Disorders              |
|       28000 - 28999          Diseases of the Blood and Blood-Forming Organs |
|       29000 - 31999          Mental Disorders                        |
|       32000 - 38999          Diseases of the Nervous System and Sense Organs |
|       39000 - 45999          Diseases of the Circulatory System      |
|       46000 - 51999          Diseases of the Respiratory System      |
|       52000 - 57999          Diseases of the Digestive System        |
|       58000 - 62999          Diseases of the Genitourinary System    |
|       63000 - 67699          Complications of Pregnancy, Childbirth, and the |
|                                  Puerperium                          |
|       68000 - 70999          Diseases of the Skin and Subcutaneous Tissue |
|       71000 - 73999          Diseases of the Musculoskeletal System and |
|                                  Connective Tissue                   |
|       74000 - 75999          Congenital Anomalies                    |
|       76000 - 77999          Certain Conditions Originating in the Perinatal |
|                                  Period                              |
|       78000 - 79999          Symptoms, Signs, and Ill-Defined Conditions |
|       80000 - 99999          Injury and Poisoning                    |
|                                                                      |
|                                                                      |
|       SOURCE:   International Classification of Diseases, 9th Edition,|
|                    Clinical Modification, Commission on Professional and |
|                    Hospital Activities, Ann Arbor, Michigan, March 1980. |
|                                                                      |
+----------------------------------------------------------------------+
```

Figure 6.   Classification of Diseases and Injuries

enhance consistency among these related systems and

facilitate the recording of medical problems identified by

DODMERB on the candidate medical examination into the PQMS
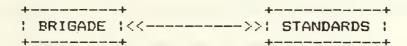
data base.

The domain of the flag fields in the STANDARDS data base

file consists of only two possible values: PQ (physically

qualified) or NQ (not physically qualified). At first, this

may seem unduly restrictive, since it implies that standards

are absolute and disregard individual circumstances.

Actually, these values are merely endpoints on a continuum

and provide a first-cut determination of an individual's

physical qualification status. As discussed in the next

section, these flags can be modified by those of the

DISQUALIFIERS data base file to reflect specific situations,

such as not physically qualified/waiver granted, not

physically qualified/waiver requested, etc.

D. DISQUALIFIERS DATA BASE FILE

A complex relationship exists between the BRIGADE and

STANDARDS data base files. This means that each midshipman

record can be related to many standards (i.e., a midshipman

can have more than one disqualifying condition) and each

standard can be related to many midshipmen (i.e., more than

one midshipman can have a certain disqualifying condition).

This many-to-many relationship can be illustrated as:

```
        +---------+                +-----------+
        : BRIGADE :<<----------->>: STANDARDS :
        +---------+                +-----------+
```

Note the two-headed arrows pointing in both directions,

indicative of a complex relationship.

Complex relationships are awkward to implement, so the

relational model decomposes such relationships using an

intersection record. As the name implies, this record

represents the merger, or "intersection," of two other

records [Ref. 5:p. 145]. PQMS uses the DISQUALIFIERS data
base file for this purpose.

    The resulting simple network can be represented as:

```
+----------+            +----------------+            +-----------+
: BRIGADE :<----->>: DISQUALIFIERS :<<----->: STANDARDS :
+----------+            +----------------+            +-----------+
```

Note that the two resulting relationships are one-to-many,
denoted by single-headed arrows pointing toward BRIGADE and
STANDARDS. This means that each record in DISQUALIFIERS can
have only one parent in BRIGADE and one in STANDARDS.

    Figure 7 describes the DISQUALIFIERS data base file.
This file contains a unique record for each instance where a
midshipman is identified to have a disqualifying condition.
The key for these intersection records is the combination of
the midshipman's alpha number and code assigned to the
disqualifying condition (i.e., Alpha+Code). Each record
also has a series of flags corresponding to the nine warfare
specialty categories. These are the flags which relax the
rigid PQ/NQ flags of the STANDARDS file. For each warfare
specialty, the flags from STANDARDS and DISQUALIFIERS are
compared. If the STANDARDS flag is PQ, the condition is not
disqualifying for that particular warfare specialty, so the
DISQUALIFIERS flag is irrelevant and the resulting status
flag is PQ. However, if the STANDARDS flag is NQ, it could
be modified by any DISQUALIFIERS flag. If the corresponding
DISQUALIFIERS flag is WG, LW, or WR the resulting status
flag would also be WG, LW, or WR, respectively. If the

```
+----------------------------------------------------------------------+
|                                                                      |
|    Data Base File:  DISQUALIFIERS                                    |
|                                                                      |
|    Description:     Intersection file which decomposes the complex   |
|                     relationship                                     |
|                     between BRIGADE and STANDARDS into a simple      |
|                     network.                                         |
|                                                                      |
|    Data Elements:                                                    |
|                                                                      |
|        Field Name    Type    Length    Remarks:                      |
|                                                                      |
|        Alpha         Char      6       Alpha number of the midshipman|
|                                        to whom                       |
|                                            the disqualifier is       |
|                                            assigned.                 |
|                                                                      |
|        Code          Char      5       Code of the disqualifying     |
|                                        condition                     |
|                                            assigned to the given     |
|                                            midshipman.               |
|                                                                      |
|        AIR_waiver    Char      2       Flag which may modify the     |
|                                        corresponding                 |
|                                            flag from the STANDARDS   |
|                                            data base file            |
|                                            for duty as a student     |
|                                            naval aviator             |
|                                            (i.e., AIR_std).          |
|                                        Permissible values include:   |
|                                            WG - not physically       |
|                                                 qualified/waiver     |
|                                                 granted              |
|                                            LW - not physically       |
|                                                 qualified/limited    |
|                                                 waiver granted       |
|                                            WR - not physically       |
|                                                 qualified/waiver     |
|                                                 requested            |
|                                            UE - undergoing           |
|                                                 evaluation/status    |
|                                                 indeterminate at     |
|                                                 this time            |
|                                        If none of the foregoing      |
|                                        flags apply,                  |
|                                            the field is left blank.  |
|                                                                      |
|        NFO_waiver    Char      2    * SAA, except student naval      |
|                                       flight officer.                |
|        OPS_waiver    Char      2      SAA, except special operations |
|                                       duty.                          |
|        WAR_waiver    Char      2      SAA, except special warfare    |
|                                       duty.                          |
|        SUB_waiver    Char      2      SAA, except submarine duty.    |
|        NUC_waiver    Char      2      SAA, except surface nuclear    |
|                                       duty.                          |
|        URL_waiver    Char      2      SAA, except unrestricted line. |
|        MC_waiver     Char      2      SAA, except U. S. Marine Corps.|
|        RL_waiver     Char      2      SAA, except restricted         |
|                                       line/staff corps.             |
|                                                                      |
|        Date          Date      8      Date of most recent update to  |
|                                       entry,                         |
|                                           MM/DD/YY format.           |
|                                                                      |
|    Primary Key:  Alpha+Code          * SAA - Same as above           |
|                                                                      |
|    Indexes:  Alpha, Code                                             |
|                                                                      |
+----------------------------------------------------------------------+
```

Figure 7.   Description of DISQUALIFIERS Data Base File

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DISQUALIFIERS flag is blank, there is no modification, and
the status flag would be NQ. The only exception to this
scheme occurs when the DISQUALIFIERS flag is UE (undergoing
evaluation). This means that regardless of what the
STANDARDS flag specifies, the midshipman's status is
indeterminate at that time, so the resulting status flag
would be UE. Figure 8 shows the decision table for this
process.

If the STANDARDS flag for a warfare specialty is:	PQ	NQ	NQ	NQ	NQ	PQ or NQ
And the corresponding DISQUALIFIERS flag is:	UE	WG	LW	WR	..	UE
Then the status flag for that warfare specialty is:	PQ	WG	LW	WR	NQ	UE

Key: UE - not UE (i.e., WG, LW, WR, or blank)
.. - blank

Figure 8. Decision Table for STANDARDS--DISQUALIFIERS Flags

The algorithm for determining a midshipman's overall
physical qualification status is slightly different.
First, the nine status flags for each disqualifying
condition are determined as described in the preceding
paragraph. These status flags are then compared within each

warfare specialty. If any single status flag is NQ, the
midshipman is not physically qualified for that warfare
specialty, and the summary flag evaluates to NQ.
Similarly, if no status flags are NQ but at least one is
UE, the midshipman's status is indeterminate, and the
summary flag evaluates to UE. This process continues in
like manner for the WR, LW, and WG flag values. A
summary flag evaluates to PQ (physically qualified) if and
only if all status flags for the particular warfare
specialty are also PQ. Of course, if a midshipman has no
disqualifying conditions, then all summary flags evaluate to
PQ. Figure 9 illustrates this algorithm.

```
        IF (any status flag for a warfare specialty = NQ)
        THEN (summary flag = NQ)

        ELSE IF (any status flag for that warfare specialty = UE)
            THEN (summary flag = UE)
            ENDIF

        ELSE IF (any status flag for that warfare specialty = WR)
            THEN (summary flag = WR)
            ENDIF

        ELSE IF (any status flag for that warfare specialty = LW)
            THEN (summary flag = LW)
            ENDIF

        ELSE IF (any status flag for that warfare specialty = WG)
            THEN (summary flag = WG)
            ENDIF

        ELSE (summary flag = PQ)
        ENDIF
```

Figure 9. Algorithm for Determining Summary Flags

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Note that because the summary flags are dependent upon the STANDARDS and DISQUALIFIERS flags and therefore subject to relatively frequent change, they are not part of the permanent PQMS data base. Instead, the summary flags are reevaluated each time a detailed or summary report is generated and either immediately displayed to the CRT screen or printer or stored to a temporary data structure as described later.

Finally, in addition to the Alpha, Code, and nine flag fields, each DISQUALIFIERS record has a date stamp which shows how current the data in the record is. As mentioned before, the key is Alpha+Code, and the file is indexed on both the Alpha and Code fields.

E. COMMENTS DATA BASE FILE

Although the BRIGADE, STANDARDS, and DISQUALIFIERS data base files provide a detailed profile of the physical qualification status of each midshipmen, they do not handle all contingencies. Therefore, PQMS also has a COMMENTS data base file which stores information which cannot be otherwise entered into the system. Figure 10 describes this file.

The Alpha field establishes the tree relationship between BRIGADE and COMMENTS; each record in COMMENTS has one and only one parent record in BRIGADE. The Comment field may contain whatever information the user feels is needed to clarify the midshipman's physical qualification

```
+------------------------------------------------------------------------+
|                                                                        |
|     Data Base File:  COMMENTS                                          |
|                                                                        |
|     Description:      Information impacting on physical qualification status which |
|                       cannot otherwise be stored by PQMS.              |
|                                                                        |
|     Data Elements:                                                     |
|                                                                        |
|            Field Name    Type    Length    Remarks:                    |
|                                                                        |
|            Alpha         Char      6       Alpha number of the midshipman to whom |
|                                               the comment applies.     |
|                                            EXAMPLE:  891234            |
|                                                                        |
|            Comment       Char      60      Comment entered as free text. |
|                                            EXAMPLE:  ACL REPAIR SCHEDULED 27JUL86 |
|                                                                        |
|            Date          Date      8       Date comment was entered into data base, |
|                                               MM/DD/YY format.         |
|                                            EXAMPLE:  07/13/86          |
|                                                                        |
|     Primary Key:  Alpha (nonunique)                                   |
|                                                                        |
|     Index:  Alpha+Date                                                |
|                                                                        |
+------------------------------------------------------------------------+
```

Figure 10.   Description of COMMENTS Data Base File

status, and the date stamp shows when the comment was

recorded.   No unique key is explicitly defined for COMMENTS,

but Alpha serves adequately as nonunique key.   The file is

indexed on the combined Alpha+Date fields.

F.   SUMMARY DATA BASE FILE

The SUMMARY data base file, described in Figure 11, is

actually a temporary structure.   When a detailed physical

qualification status report is generated (see Figure 1),

SUMMARY provides a scratchpad for storing intermediate and

final results of the summary flags algorithm of Figure 9.

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```
+----------------------------------------------------------------------+
|                                                                      |
|    Data Base File:   SUMMARY                                         |
|                                                                      |
|    Description:     Temporary data base file which stores personal data and summary  |
|                     flags for detailed or summary physical qualification reports      |
|                                                                      |
|    Data Elements:                                                    |
|                                                                      |
|          Field Name    Type    Length    Remarks:                    |
|                                                                      |
|          Alpha         Char       6      Alpha number of the midshipman.  |
|                                                                      |
|          Name          Char      25      Last and first names of the midshipman,  |
|                                             separated by a comma and truncated.  |
|                                          EXAMPLE:  MCGIFFIN, PHILO    |
|                                                                      |
|          Company       Char       2      Company to which midshipman is assigned.  |
|                                                                      |
|          AIR_flag      Char       2      Summary flag which indicates midshipman's  |
|                                             physical qualification for duty as a  |
|                                             a student naval aviator.              |
|                                          Permissible values include:  |
|                                             PQ - physically qualified  |
|                                             WG - not physically qualified/waiver  |
|                                                  granted               |
|                                             LW - not physically qualified/limited  |
|                                                  waiver granted        |
|                                             WR - not physically qualified/waiver  |
|                                                  requested             |
|                                             UE - undergoing evaluation/status  |
|                                                  indeterminate at this time  |
|                                             NQ - not physically qualified  |
|                                                                      |
|          NFO_flag      Char       2   *  SAA, except student naval flight officer.  |
|          OPS_flag      Char       2      SAA, except special operations duty.  |
|          WAR_flag      Char       2      SAA, except special warfare duty.  |
|          SUB_flag      Char       2      SAA, except submarine duty.    |
|          NUC_flag      Char       2      SAA, except surface nuclear duty.  |
|          URL_flag      Char       2      SAA, except unrestricted line.  |
|          MC_flag       Char       2      SAA, except U. S. Marine Corps.  |
|          RL_flag       Char       2      SAA, except restricted line/staff corps.  |
|                                                                      |
|    Primary Key:  Alpha                   * SAA - Same as above        |
|                                                                      |
|    Index:  Alpha or Company+Alpha (depending on report being generated)  |
|                                                                      |
+----------------------------------------------------------------------+
```

Figure 11.   Description of SUMMARY Data Base File

When a summary reports are generated (see Figure 2), SUMMARY stores personal data from the BRIGADE file, as well as the results of the summary flag algorithm. In either case, the contents of SUMMARY are erased after the report is produced, leaving only a superstructure which can be reused for the next detailed or summary report.

The Name field in the SUMMARY file is a combination of the midshipman's last and first names, truncated to 25 characters to allow use of the built-in dBASE III report generator for summary reports. The other fields are self-explanatory. The key for SUMMARY is the Alpha field. When summary reports are generated, indexes are created "on the fly" based on either the Alpha or Company+Alpha fields, depending on the desired sort sequence. These indexes are also temporary and erased after the reports are printed.

VI.   PRINCIPLES OF OPERATION

Consistent with the data structure-oriented design
approach, the PQMS data base files provide the basis for the
procedural aspects of the system.   In general, a hierarchy
of modules exists as illustrated at a first level of detail
by Figure 12.

```
+----------------------------------------------------------------------+
:                                                                      :
:                                                                      :
:                          +----------+                                :
:                          :   PQMS   :                                :
:                          +----------+                                :
:                               :                                      :
:    +---------+----------+----------+---+-------------+------------+   :
:    :         :          :.         :              :            :   :
: +-------+ +---------+ +-----------+ +---------------+ +-----------+ +-----------+ :
: : Logon : : Update_ : :  Update_  : :    Update_    : : Generate_ : :  Print_   : :
: :       : : BRIGADE : : STANDARDS : : DISQUALIFIERS : :  Reports  : : STANDARDS : :
: +-------+ +---------+ +-----------+ +---------------+ +-----------+ +-----------+ :
:                                                           :                      :
:                                                     +-----------+                :
:                                                     :  Update_  :                :
:                                                     :  COMMENTS :                :
:                                                     +-----------+                :
:                                                                                  :
+----------------------------------------------------------------------+
```

Figure 12.   Hierarchy of PQMS Modules

The system is menu-driven, so no knowledge of the underlying
dBASE III language or programs is needed to effectively
interact with PQMS.   Visual and auditory prompts guide the
user through all facets of the program, and extensive error-
trapping validates inputs and maintains the integrity of the

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data bases. The following sections overview the PQMS
principles of operation.

A. ENTERING AND EXITING PQMS

    To begin using PQMS, the user must first enter a
password. (The user gets three attempts at this, after
which processing is aborted and control returned to the
microcomputer's operating system.) After a successful
logon, the user gets an opportunity to change the current
password, an action strongly encouraged from time to time to
prevent unauthorized access to the system. An introductory
banner is displayed, followed by a Privacy Act Warning.
PQMS then presents its main menu from which the user invokes
the subordinate processing modules. When the user decides to
exit PQMS, the Privacy Act Warning is again displayed before
control reverts to the operating system.

B. UPDATING PERSONAL DATA

    There are actually two phases to updating the personal
data in the BRIGADE data base file. The first is an
off-line process involving the Naval Academy Time-Sharing
System (NATS) and the Brigade Roster File (BROSTER).
Running a NATS program called BRIGREAD***, the user creates
a file containing the alpha number, Social Security number,
last name, first name, sex, date of birth, and company of
every member of the Brigade. This file is then downloaded
from the NATS Honeywell DPS 8 computer through a 2400-baud,

hard-wired line to the Branch Clinic microcomputer, using the KERMIT communication protocol on both computers to ensure reliable, error-checked data transfer.

When this data is on the hard disk storage unit of the microcomputer, PQMS can update the BRIGADE data base as follows. After ensuring that the new file of personal data is in place, PQMS erases the old BRIGADE data base and its indexes, creates an empty data structure of the appropriate format, appends to that structure from the downloaded file, and reindexes the new BRIGADE data base. PQMS deletes then records in the DISQUALIFIERS and COMMENTS files which no longer have a counterpart in BRIGADE, and control reverts to the main menu.

This process is unlike others in PQMS in that it takes place in batch mode and only periodically, rather than on-line and continuously as is typical of the other updates. This raises a question as to whether the overall performance of PQMS suffers due to the BRIGADE data being outdated. This is not the case at all! Martin has identified five classes of data according to increasing complexity of update [Ref. 7:pp. 281-284]:

   Class 0 - Unchanging data

   Class 1 - Data which are updated by simple replacement

   Class 2 - Data with independent nonrepeatable updates

   Class 3 - Data with time-critical updates

   Class 4 - Data for which an update may trigger an action
             in a different machine

The data element of BRIGADE most susceptible to change is

Company, which is known to change at the end of the fourth

class (freshman) year and on some other rare occasions. All

other data elements are unchanging, except for correction of

erroneous initial entries. Therefore, the overall

classification for BRIGADE is Class 1, in which case the

replacement scheme used by PQMS is quite appropriate.

Additional benefits are that the Branch Clinic does not have

to replicate the substantial efforts of the Midshipman

Personnel Office by initially entering or maintaining the

data and that consistency between BROSTER and PQMS is

assured.

C.   UPDATING STANDARDS DATA

Updating the STANDARDS data base file involves three

activities: adding, modifying, and deleting standards. When

adding to the data base, the user first enters the code for

the new standard. The entry is checked to ensure that it is

five characters long and than the code has not already been

used for any existing standard; the user is reprompted if

the code fails either test. If the code is valid, a blank

record is appended to STANDARDS, and the user enters a text

description for the disqualifier and the standard flags for

the nine warfare specialties (i.e., AIR_std, NFO_std, etc.).

Each flag is validated as PQ or NQ before proceeding to the

next. Before storing and indexing the new record, PQMS

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displays all input and asks for confirmation. Based on the user's response, the data is either committed to the data base along with the current date or cleared from memory.

To modify a standard, the user first enters its five-digit code. If the code does not exist, an error message results. Otherwise, PQMS displays the code, text description, and flags for the standard. After confirming that this is the desired record, the user enters a new series of flags, which are also validated as being PQ or NQ. As before, the user must confirm that the new data is to be committed to the data base, at which point the Date field of the record is changed as well.

When attempting to delete a standard, PQMS first checks to see if the code which the user entered exists. If not, an error message results. If it does, the DISQUALIFIERS files is searched to see if any intersection records exist for that code. To maintain data base integrity, PQMS will not delete a standard which has any associated intersection records. Assuming this is not the case, the code, text description, and flags for the standard are displayed. The record is deleted only after approval by the user.

Access to any of these three processes is through the Update_STANDARDS module. Once a subordinate module is entered, the add, modify, or delete cycle continues until a null (blank) is entered at the code prompt. Control then reverts back to the superordinate, Update_STANDARDS module.

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D. UPDATING DISQUALIFIERS DATA

Updating the DISQUALIFIERS data base file is similar in several respects to updating STANDARDS. Options include adding, modifying, and deleting disqualifiers. Access to these is through the Update_DISQUALIFIERS menu, and after entering any of the subordinate modules, processing loops within that module until the user responds to the prompt for an alpha or Social Security number with a null value. On the other hand, updating DISQUALIFIERS requires some additional steps due to the inherent complexity of intersection records.

Adding to the DISQUALIFIERS file begins by inputting either the alpha or Social Security number of the midshipman to whom the new disqualifier will be assigned. This flexibility is built into PQMS because Naval Academy authorities typically identify midshipmen by alpha number, whereas the Branch Clinic uses Social Security number almost exclusively to identify Health Records, physical examinations, and the like. Assuming the length of the value provided is valid (i.e., 6 or 9 characters), PQMS chooses either the Alpha or SSN index and searches for the input value. If it is not found, an error message results, reprompting the user for a valid key. Otherwise, PQMS displays the midshipman's full name and company number and asks for confirmation that this is the desired individual. The user then enters the code of the disqualifier to be

assigned to that midshipman. A null value aborts the cycle, and an invalid entry causes reprompting. Another crucial check is made to ensure that an intersection record does not already exist for that midshipman and disqualifier code; if one does, an error message and reprompt are displayed. Next the code, text description, and standard flags for the disqualifier are displayed, and the user enters any waiver flags for the nine warfare specialties (i.e., AIR_waiver, NFO_waiver, etc.). Each input is validated as being WG, LW, WR, UE or blank before continuing to the next waiver flag. PQMS then asks the user to approve entry of the new intersection record into the data base and either appends the current date or discards all input.

The preliminary steps in modifying a DISQUALIFIERS record are similar to those above. A valid alpha or Social Security number yields the name and company number of the midshipman. A null code entry aborts the current modification process, while an error message and reprompt occur if an intersection record cannot be found for the given midshipman and disqualifier code. When the intersection record is found, the text description of the disqualifier, standard flags, and existing waiver flags are displayed. The user then inputs the new waiver flags, each of which is validated before continuing to the next. After confirmation, PQMS modifies the intersection record to

reflect the new set of waiver flags and current date;
otherwise, the record left unchanged.

Deleting a disqualifier is identical to modifying one
through the point at which the text description, standard
flags, and old waiver flags are displayed. PQMS then either
deletes or retains the intersection record, based on the
user's confirmation input.

E. GENERATING PHYSICAL QUALIFICATION STATUS REPORTS

The Generate_Reports menu is the starting point for
producing detailed or summary physical qualification status
reports. The formats of these reports were presented
in Figures 1 and 2. Five options are available:

1. Detailed report on one individual (to CRT screen),
    including adding and deleting comments

2. Detailed report on one individual (to printer)

3. Detailed reports on all midshipmen in a given
    company and year group (to printer)

4. Summary report on all midshipmen in a given company,
    sorted by year group (to printer)

5. Summary report on all midshipmen in a given year
    group, sorted by company (to printer)

These are the most demanding activities performed by PQMS,
in terms of both input/output and processing, and
consequently the most time-consuming. The sequence of the
options roughly corresponds to the increasing complexity of
the underlying processing tasks.

A detailed report on an individual, either to the CRT
screen or printer, requires only one user input--a valid

alpha or Social Security number. Using either of these,
PQMS locates the midshipman record in the BRIGADE data base
and displays the personal information contained in that
file. Using the individual's alpha number, PQMS then
searches the DISQUALIFIERS file for any related intersection
records. If none are found, a statement to that effect is
produced, and the summary flags for all warfare specialty
default to PQ. Otherwise, PQMS uses the DISQUALIFIERS Code
field to find the corresponding record in STANDARDS and
compares the corresponding pairs of flags using the decision
table of Figure 8 (i.e., AIR_std vs. AIR_waiver, NFO_std
vs. NFO_waiver, etc.). The code, text description, date of
the most recent change to the intersection record, and the
nine status flags for that disqualifier are displayed, and
the status flags are evaluated using the algorithm for
summary flags of Figure 9. This process continues for all
disqualifiers assigned to the midshipman. The nine summary
flags are then displayed in their final form.

At this point, the procedures for CRT display and
printing diverge. In both cases, the alpha number is used
to find all related records in the COMMENTS data base. When
the detailed report is printed, these are directly output in
order from the oldest to most recent. Because of the 80 x
25 character limitation of a CRT screen, however, output
pauses after the nine summary flags, and the user is
prompted to press any key to clear the screen and display

any comments. This second screen also affords the user the opportunity to delete old comments or add new ones. No error-trapping is used per se. Instead, the comments screen is refreshed after each deletion or addition, after which the user may correct any errors.

During the annual precommissioning physical examination evolution, midshipmen are usually processed in groups based on their company. To facilitate this, PQMS provides the ability to print detailed reports on all individuals in a particular company and year group. The user begins by entering the desired company number, then year group. A null value for either aborts the process. When valid inputs have been entered for both, the reports are printed as described previously for individual detailed reports, each on a separate page and in alphabetical order.

To assist the Brigade Officers and Division of Professional Development in their career counseling roles and in administering the summer cruise and service selection programs, PQMS can produce summary physical qualification status reports on all midshipmen in a particular company or year group. The processing logic for these reports is virtually identical. First, the user enters the desired company (or year group). As before, the input is validated, and a null entry aborts the process. Using the BRIGADE, DISQUALIFIERS, and STANDARDS data bases, PQMS determines the warfare specialty summary flags for each midshipman in the

chosen subset. These are stored in the SUMMARY data
structure, along with the midshipman's alpha number, name,
and sex. These records are then indexed and printed. The
company report lists each year group on a separate page,
while the year group report lists each company on a separate
page. After either report is printed, the SUMMARY data
structure is purged, leaving only its shell for use by for
the next report, and the index is erased.

F. PRINTING STANDARDS DATA

The STANDARDS data base file can be printed in its
existing form (see Figure 3) as a reference guide for
updating the PQMS data base or to allow review by an outside
authority. The procedure is straightforward. The user
simply chooses whether the listing is to be sorted by code
or alphabetically. PQMS then uses the appropriate index and
produces a printout of all records in STANDARDS in the
desired order.

VII.   <u>SUMMARY</u>

A.   HARDWARE AND SOFTWARE CONFIGURATION

Systems design consists of two phases, logical design
and physical design. So far, this thesis has only dealt
with the logical design of the Physical Qualification
Monitoring System, addressing design issues such as outputs,
inputs, data base files, and procedures. There is nothing
which precludes implementation of the PQMS logical design on
NATS or any other Naval Academy computer system.

Because of the development environment for the PQMS,
however, the system was explicitly designed for
implementation on a microcomputer. The hardware and
software selected for the PQMS include:

- Televideo XL Portable Computer (with RAM expansion to
  512 Kbytes)

- Xebec 10HB External Hard Disk

- Citizen MSP-10 Dot Matrix Printer

- Microsoft MS-DOS (Version 2.11)

- dBASE III (Version 1.1)

- KERMIT Communications System

Actually, once the decision was made to use a microcomputer,
there was little choice regarding the hardware and software.
Based on a contract awarded to Federal Data Corporation in
May 1985, the Televideo XL is now the standard personal
microcomputer for the Navy and Air Force. Except for KERMIT

which is public-domain software, the PQMS configuration is based exclusively on that contract.

Federal procurement contracts are often a mixed blessing. This is particularly true of the PQMS. On the positive side, the problem of choosing from the growing number of microcomputers in today's market was eliminated, as were problems stemming from involving multiple vendors when building a system. The built-in serial port allows direct connection of the Televideo XL to the 2400-baud, hard-wired NATS communications lines, and the 10-megabyte external hard disk provides sufficient storage capacity for the PQMS files.

Unfortunately, the Televideo lacks a cassette tape or similar backup facility, so floppy disks are the primary backup medium for the PQMS. Since some of these files (e.g., DISQUALIFIERS, COMMENTS) may exceed the 360-kilobyte capacity of a floppy disk, other alternatives are needed. As an interim measure, larger files can be backed up to NATS, but the long-term solution is a cassette tape backup unit. Another potential problem with the Televideo XL is speed. This microcomputer uses an Intel 8088 microprocessor chip and operates on a 4.77 MHz clock. While these are adequate for some applications, the PQMS detailed physical qualification status reports involve a large volume of input/output and a very heavy processing load, especially if the report is on an entire year group. The hard disk helps

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somewhat by speeding up input/output, but the processor speed is the main problem. Potential solutions are to enhance the Televideo with an accelerator expansion card or to upgrade to a faster microcomputer (e.g., IBM PC-AT, Compac DeskPro 286, etc.).

B. PQMS AS AN EXPERT SYSTEM

Expert systems have received considerable attention in recent years and are at the heart of what is known as the "fifth generation" of computer technology. These systems are programs which have the knowledge and capability built in to allow them to operate at the expert's level. The two principle components of an expert system are a knowledge base and inference engine. The knowledge base contains both general facts of the problem domain and the heuristic or experiential knowledge of one or more experts from that field. The inference engine is the reasoning process which applies the domain and heuristic knowledge to the situation at hand to find an answer or solution. Many inference engines are generic in that they can be used with different knowledge bases to address problems from a variety of domains. [Ref. 8:pp. 63-64, 76-79]

The PQMS is not designed as an expert system. Its reasoning processes are part of the program and cannot be segmented out for general use in other domains. However, the system closely mimics an expert system through its

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ability to make physical qualification determinations using stored knowledge, to explain those determinations via its detailed reports, and to pass on knowledge from one generation of user to the next.

C. PQMS AS A PROTOTYPE

Prototyping is a term long associated with the more mature engineering fields. For example, automobile and aircraft manufacturers have for years developed prototypes to test and refine new design concepts before going into full-scale production. Computer hardware engineers have also adopted this strategy. Based on a hardware requirements analysis, a preliminary configuration is designed using off-the-shelf and/or custom-built components. This prototype is then tested and modified until all requirements are met [Ref. 4:p. 9]. More recently, software engineers have seen the applicability of such proven techniques from the older engineering disciplines to their own, and prototyping software is becoming increasingly more common.

There are a number of reasons for prototyping software systems. Sometimes prototypes are warranted because of the high cost or high risk inherent in a given project; consider the relevance of software prototyping to the Strategic Defense Initiative. Certain types of systems (e.g., decision support systems) are best developed using

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prototyping because of their lack of structure and non-repetitive nature. [Ref. 3:p. 6]

PQMS does not fall into either of those categories, but there are still compelling reasons for using this approach. Although the role of the Branch Clinic in monitoring physical qualifications is well-understood, those information needs are not easily translated into a formal requirements specification. Even if they were, prototyping is still appropriate in instances where the analysts have no prior experience in building such a system [Ref. 9:p. 228]. This is certainly the case with PQMS. Therefore, the system has been designed as a prototype to clarify the information requirements of the Branch Clinic and to allow for the lack of experience of the analyst/programmer.

D. EXTENSIONS OF PQMS CONCEPTS

The PQMS prototypes a highly specialized, site-specific application. However, there are at least two possible extensions of this system.

The logical design of the system should be adaptable for use by the other service academies. West Point and the Air Force Academy also commission their graduates into a variety of warfare specialties, each with its own physical qualification standards. The Coast Guard Academy sends all graduates to sea duty, but still must determine whether they are physically qualified for a regular Coast Guard

commission. Those who are not must accept commissions in Coast Guard Reserve.

Second, the idea of establishing a knowledge base of physical qualification standards has merit. This knowledge base could be distributed to naval medical treatment facilities, along with programs to compare an individual's physical examination results with those standards. This could provide invaluable assistance in those settings where the health care provider is not familiar with current physical standards or with the waiverability of certain disqualifying conditions. In addition, by building the knowledge base separate from the underlying programs, updates could be easily compiled and issued to field activities, ensuring uniform use of current information throughout the Navy.

LIST OF REFERENCES

1. United States Naval Academy, 1985-1986, Catalog,
   U. S. Naval Academy Public Affairs Office.

2. Bureau of Medicine and Surgery Instruction 5450.9D.

3. Cash, James I., Jr., McFarlan, F. Warren, and McKenney,
   James L., Corporate Information Systems Management:
   Text and Cases, Richard D. Irwin, Inc., 1983.

4. Pressman, Roger S., Software Engineering: A
   Practitioner's Approach, McGraw-Hill, Inc., 1982.

5. Kroenke, David M., Database Processing: Fundamentals,
   Design, Implementation, 2d ed., Science Research
   Associates, Inc., 1983.

6. International Classification of Diseases, 9th Revision,
   Clinical Modification, Commission on Professional and
   Hospital Activities, March 1980.

7. Martin, James, Design and Strategy for Distributed Data
   Processing, Prentice-Hall, Inc., 1981.

8. Feigenbaum, Edward A. and McCorduck, Pamela, The Fifth
   Generation, Addison-Wesley Publishing Company, 1983.

9. Senn, James, Analysis and Design of Information Systems,
   McGraw-Hill, Inc., 1984.

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